AN ANATOMICAL AND EMBRYOLOGICAL STUDY OF THE PERINEUM *

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INTRODUCTION

The foundation of all perineal surgery is an exact knowledge of the rectourethralis muscle and Devonvilliers fascia. The information gained from a perusal of the literature is unsatisfactory, as the nomenclature is confusing, and the descriptions vary markedly, being based upon studies of individual variations. The exact origin and insertion of the rectourethralis muscle is most important, since, aside from the loss of urinary control caused by cutting the external vesical sphincter, the only valid objection urged against the perineal prostatectomy is the danger of a rectal tear due to the improper dividing of this muscle. Devonvilliers fascia is the goal aimed for in every perineal operation, and when its glistening white layer comes into view the surgeon feels that he has passed the region of uncharted dangers. This fascia, which separates the rectum from the prostate, can be split into two layers, and hence the didactic statement, that it represents the fused layer of the fetal peritoneum, has been generally accepted.

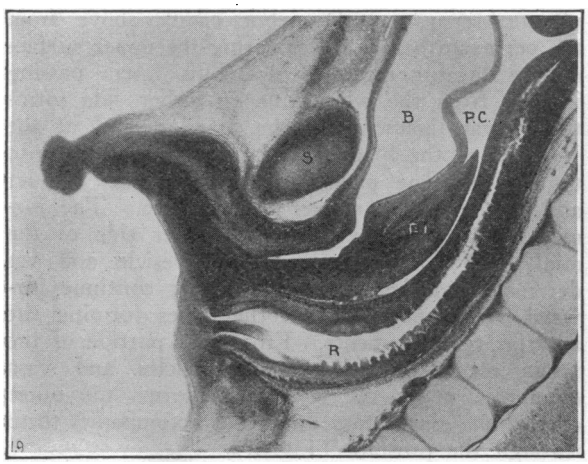

Fig 1.—Mid-sagittal section of genito-urinary region of 46 mm. human embryo. The fused layers of fetal peritoneum have not been wholly absorbed, as is shown by the presence of small "cysts"; S, symphysis; B, bladder; PC, peritoneal cavity; ED, ejaculatory duct; R, rectum. (Embryo, Carnegie Institute, 1686, slide 23, row 1, section 2.) X 21.

HISTORY

Devonvilliers, in 1836, enunciated the hypothesis that the center or nucleus of the perineum is a prerectal raphe or "aponeurosis prostato-perintonele." This fibrous plane is triangular in shape with a truncated apex deep behind which blends with the superior layer of the triangular ligament, while the base at the top is adherent to the inferior face of the peritoneum, thereby helping form the rectovesical cul-de-sac. The posterior layer is in contact with the rectum to which it is joined with very loose cellular tissue, while from the superior face arise dense cellular elongations which envelop the seminal vesicles, vasa-deferentia and inferior extremities of the ureters.

In 1899 Cuneo and Veau went a step further and stated that the prostato-peritonele aponeurosis of Devonvilliers was formed by a fusion of the fetal peritoneum of the rectovesical cul-de-sac, the two peritoneal layers combining and forming an aponeuotic sheet with a complete correspondence of the arrangement of the peritoneum in embryos of both sexes. Even if the original fused layers disappear they make the framework for later layers of fibers. As proof of this primitive fusion they call attention to evidences of incomplete fusions such as vesico-seminal cysts, perineal hernias and the cul-de-sac of Douglas in the female.

The following year Proust stated that, while the ideal scheme was to admit the existence of a prerectal fascia forming a nucleus of the perineum, as suggested by Devonvilliers, unfortunately the hypothesis could not be reconciled with surgical anatomy, for while it was easy to separate the coverings of the prostate into anterior and posterior layers, it was most difficult to peel out the seminal vesicles, bladder and rectum.

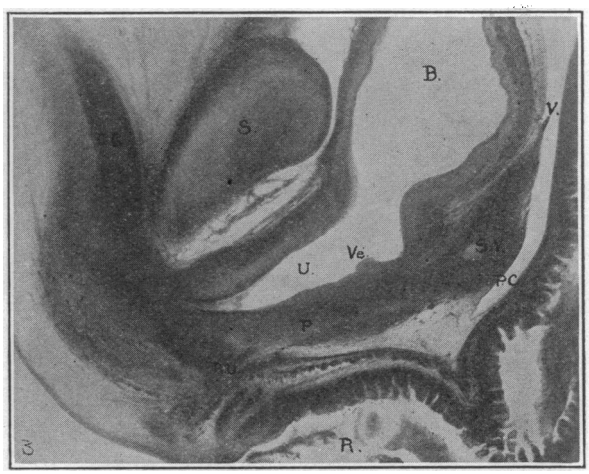

Fig. 2.—Sagittal section through pelvis of 67 mm. human embryo: B, bladder; U, urethra; Ve, verumontanum; V, vas deferens; SV, seminal vesicle; P, prostate; PC, peritoneal cavity; R, rectum; RU, rectourethralis muscle; CC, corpus cavernosus; S, symphysis pubis. (Embryo, Carnegie Institute, 1656, slide 47.) X 18.5.

MATERIAL AND METHODS

The material used for microscopic study consisted of serial sections of 31 human embryos obtained from the collection of the Carnegie Institute of Embryology. Several specimens of the rectourethralis muscle were obtained at operation, sectioned and stained with differential stains. The microscopic investigations consisted of dissections of both preserved and fresh cadavers of infants and adults. A glass model was constructed of the pelvis of a seven months fetus, cut transversely in sections 100 microns thick. An Edinger projection apparatus was used, and the sections traced directly on 8x10" glass plates by means of various colored Higgins inks. Distortion of the model was prevented by keeping the magnification in proportion to the thickness of the sections. The glass plates were then stacked, divided into packs about two inches thick and bound firmly with adhesive plaster. When mounted in a frame, with electric lights behind them, they appeared as colored gela-

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tin molds in a glass case. A preparation of this kind is far superior to a wax model for perineal studies, as it gives a transparent presentation of an entire region, which in this model shows ten structures and their relationships, instead of an opaque representation of a single organ.

EMBRYOLOGY OF THE PERINEUM

The primitive pelvis is divided into a ventral and dorsal half by the fusion of the two urogenital folds which unite throughout their whole length in the median line. This frontal partition is termed the genital cord and appears in embryos between 19.4 and 20 mm. It was formerly believed that sexual differences appeared with the formation of the genital cord, but Spaulding has recently shown that they are present from the beginning. The rectovesical pouch which extends to the floor of the perineum in a 15.5 embryo reaches just below the level of the verumontum in a 46 mm. specimen (Fig. 1), and at 240 mm. reaches to the middle of the seminal vesicles. In many of the specimens studied the peritoneal pouch was asymmetrical, being slightly deeper on one side than the other.

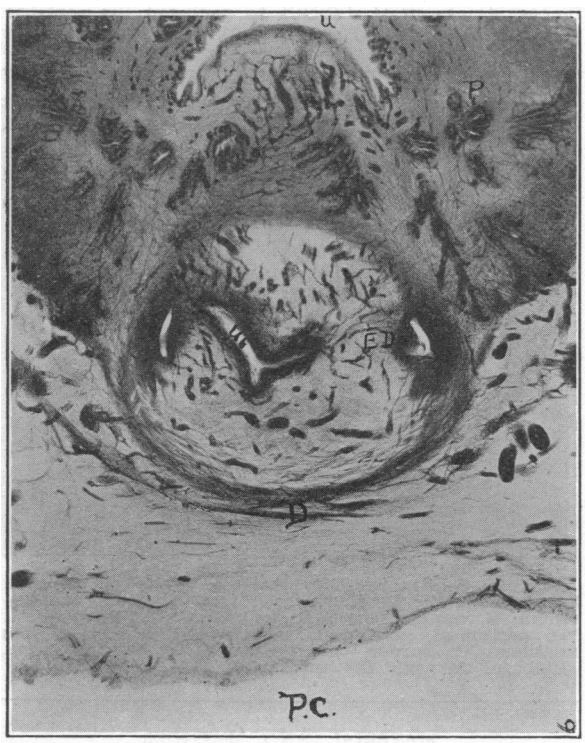

Fig. 3.—Transverse section through posterior urethra, distal to verumontanum, of 210 mm. human embryo. A dense fascia surrounds the utricle and ejaculatory ducts, separating them from the prostatic tissue: U, urethra; Ut, utricle; ED ejaculatory duct; P, prostate; PC, peritoneal cavity; D, Denonvillier's fascia. (Embryo, Carnegie Institute, 2402, slide 245, section 2.) X 18.5.

When the peritoneal layers fuse, the mesothelium is absorbed and disappears, leaving only a bed of mesenchyme. In one 25 mm. embryo there was an apparent raphe as the absorption was not complete; in other specimens showing incomplete absorption the line of fusion was marked by isolated portions simulating cysts—all lying closer to the rectum than to the prostate. In none of the older specimens, where differentiation is more complete, is there any evidence of the persistence of the fused peritoneal layers as a raphe or cysts (Fig. 2).

GROSS ANATOMY OF PELVIC FASCIA

Because of the confused nomenclature, a brief description of the gross anatomy of the pelvic fascia is necessary. This layer is a continuation of the transversalis fascia in front and the iliac fascia on the sides. It is made up of a primary parietal layer and a secondary visceral layer. The parietal layer forms a cylindrical membrane attached above and below to the inlet and outlet of the pelvis, forming the pyriformis fascia behind, the posterior layer of the triangular ligament in front, and laterally the obturator fascia and ischiorectal fascia (or covering of the under surface of the levator ani muscle).

The visceral pelvic fascia is a membranous diaphragm separating the pelvic cavity above from the perineum below and covering the upper surface of the levator ani muscle. This fascia passing inward from the white line on either side forms the lateral ligaments of the bladder, and at the junction of the bladder and prostate it splits into two layers, one passing up around the bladder and the other down over the prostate. The former splits into two layers on either side of the midline to enclose each seminal vesicle and vas deferens, and then bending together continue forward over the bladder to the pubes forming the anterior true ligaments. From that portion of the fascia overlying the seminal vesicles and vasa deferentia arises the layer that forms the outer coat of the ejaculatory ducts and accompanies them through the prostate (Fig. 3).

The prostate has a capsule which consists of a comparatively thin layer of fibrous tissue and involuntary muscle fibers closely adherent to the gland and penetrating the substance. Being continuous with the glandular stroma, it cannot be separated from it without laceration of the gland tissue. It is analogous to the fibrous capsules of the liver and spleen.

The layer of fascia which passes down around the prostate forms a funnel-shaped sheath which is complete except for a vertical band on the anterior surface. Here, because of the extra strain placed on the pelvic floor, due to the upright posture of man, there has been a condensation of fascia and fibrous prolongations between sheath and capsule which unite them so firmly that it is impossible to separate them.

Devonvilliers fascia or the fascia between the prostate and the rectum consists of two layers, one covering the prostate and the other the rectum. These two layers meet above at the vesico-prostatic junction, where they both spring from that portion of the visceral fascia which may be said to stretch across the pelvis between the urogenital apparatus and the rectum. When the rectourethralis muscle is divided the incision should likewise divide the posterior or rectal layer of Devonvilliers fascia,

which is then pushed back with the rectum. Thus is formed the "espace decollable rectroprostatique" or separable space, and the anterior layer of Devonvilliers fascia or sheath of the prostate is exposed. The texture of this resistent membranous layer resembles the dartos, being made up of glistening fibrils most pronounced in the midline.

GROSS ANATOMY OF THE RECTOURETHRALIS MUSCLE

The rectourethralis muscle is of primary importance to the perineal surgeon since it is responsible for the acute anterior flexure of the rectum and the consequent approximation to the apex of the prostate (Fig. 4). A bundle of muscle fibers is sent to the coccyx from the posterior thickened longitudinal band of the rectum, thus forming the recto-coccygeus muscle; and a corresponding bundle arises anteriorly at the level of the verumontanum

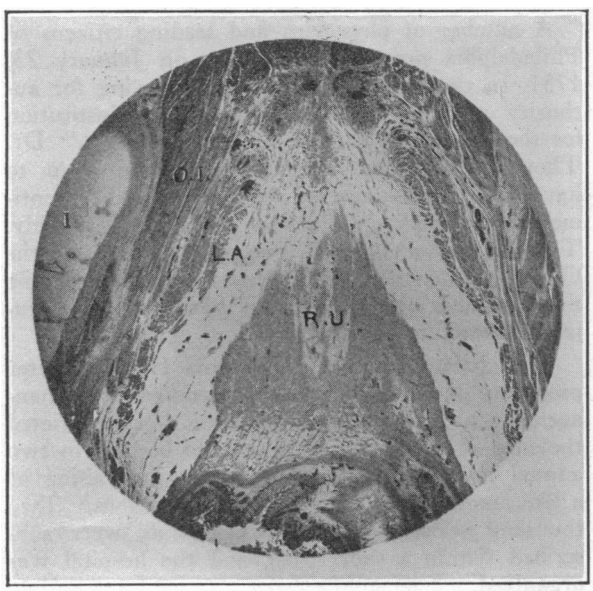

Fig. 4.—Transverse section through pelvis of 208 mm. human embryo, showing the relationship between the rectourethralis and levator ani muscles: RU, recto-urethralis muscle; LA, levator ani muscle; OI, obturator internus muscle; I, ilium. (Embryo, Carnegie Institute, 2402, slide 261, section 1.) X 7.

and passes to the raphe of the external vesical sphincter, thereby forming the rectourethralis muscle (Fig. 5). This raphe fuses with the under side of the central tendon of the perineum, which lies about 2½ cm. in front of the anus and is formed by an interdigitation of the fibers of the external anal sphincter, the transverse perineal and the bulbocavernosus muscles.

A study of the specimens of the rectourethralis muscle obtained at operation showed smooth muscle fibers at one end flowing into a bed of elastic tissue containing striated fibers at the other.

Contrary to the generally accepted view the levator ani muscle lies lateral to the prostate and is definitely separated from it, and sends no fibers over its posterior surface either directly or indirectly through the rectourethralis.

DISCUSSION

The fascia being merely condensations of connective tissue, have marked individual variations in density. From the urological standpoint they are of interest not only as structural supports, but as protective partitions which guide the paths of extravasations of urine, infections and malignant growths. The perineum has a three-fold protection from extravasation of urine due to rupture of the anterior urethra, the first barrier being Bucks fascia, then Colles and lastly (the anterior layer of) Devonvilliers fascia. The latter is of primary importance in preventing cancer of the rectum spreading anteriorly and effectively confines early cancer of the prostate so that it can be entirely eradicated by means of the radical prostatectomy of Young.

Two anomalies of interest to the urologist were

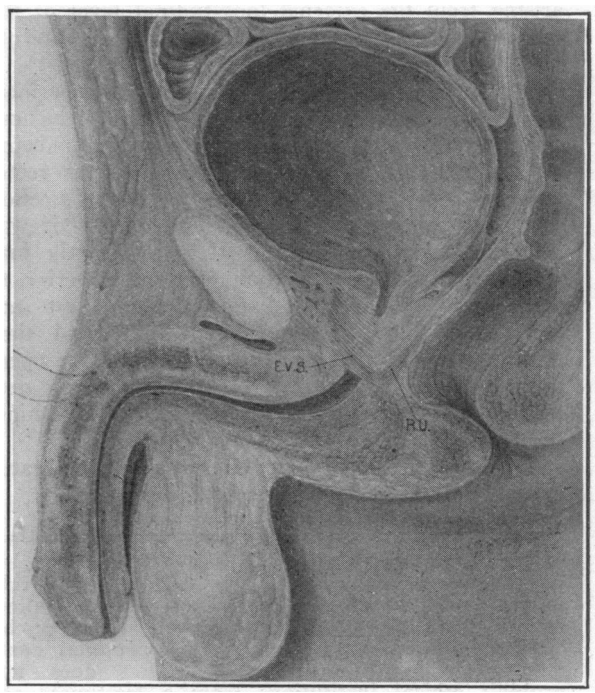

Fig. 5.—Sagittal section through pelvis of adult, showing diagramatically the relation existing between the external vesical sphincter (EVS) and the rectourethralis muscle (RU); if the dissection follows the posterior surface of this muscle the rectum will be opened, but if the muscle is cut at its junction with the external vesical sphincter the rectum will drop back and the prostate be exposed.

seen in the embryos studies. In the glass model of Embryo 2375 the testicles show in the inguinal canals, the right one being normal, but the left is rotated so that the globus minor lies above and the globus major below. Could not this be the forerunner of a torsion of the testicle?

Embryo 1656 has a long Cowpers duct, whose orifice is near the meatus. This is of particular interest since no adequate theory has yet been advanced to explain the origin of periurethral ducts. In an adult such a structure would undoubtedly be classified as such.

SUMMARY

1. Devonvilliers fascia is not formed by a fusion of the fetal pelvic peritoneal.

2. The rectum, at the level of the prostate, is surrounded by a more or less definite cuff of

connective tissue in which the lowest part of the peritoneal cavity dips.

3. At no stage of development is the peritoneum in contact with the prostate, it always being nearer to the rectum than to the prostate.

4. The recto-prostatic space is filled at first with a synticium or mass of embryonic connective tissue cells; eventually differentiation occurs and there is a condensation of connective tissue anteriorly and posteriorly. The anterior layer covering the prostate is the thicker and the elastic tissue fibrils predominate, thereby causing the shiny appearance characteristic of Devonvilliers fascia.

5. A sheath of fascia surrounds the ejaculatory ducts and utricle as they pass through the prostate.

6. The rectourethralis is a sheet of muscle arising from the external longitudinal layer of the rectum and ending in the raphe of the external vesical sphincter.

7. In exposing the prostate by the perineal route the rectourethralis muscle should be cut close to the central tendon, the incision being sufficiently deep to sever the posterior or rectal layer of Devonvilliers fascia, and the dissection continued anteriorly to the muscle, for if the posterior layer is followed it leads directly into the rectum. If the incision is made anterior to the central tendon the dissection leads first into the venous bulb, causing hemorrhage, and then through the external vesical sphincter. The opening of the rectum is avoided, but there is a prolonged and often permanent loss of vesical sphincter control.

8. Long Cowpers ducts ending near the meatus probably develop as periurethral ducts.

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Resolution on Medical Ethics—"Solicitation of patients by physicians as individuals, or collectively in groups by whatsoever name these may be called, or by institutions or organizations, whether by circulars or advertisements, or by personal communications, is unprofessional. That does not prohibit ethical institutions from a legitimate advertisement of location, physical surroundings and special class—if any—of patients accommodated. It is equally unprofessional to procure patients by indirection through solicitors or agents of any kind, or by indirect advertisement, or by furnishing or inspiring newspaper or magazine comments concerning cases in which the physician has been or is concerned. All other like self-laudations defy the traditions and lower the tone of any profession, and so are intolerable. The most worthy and effective advertisement possible, even for a young physician, and especially with his brother physician, is the establishment of a well-merited reputation for professional ability and fidelity. This cannot be forced, but must be the outcome of character and conduct. The publication or circulation of ordinary simple business cards, being a matter of personal taste or local custom, and sometimes of convenience, is not per se improper. As implied, it is unprofessional to disregard local customs and offend recognized ideals in publishing or circulating such cards.

"It is unprofessional to promote radical cures; to boast of cures and secret methods of treatment or remedies; to exhibit certificates of skill or of success in the treatment of disease; or to employ any methods to gain the attention of the public for the purpose of obtaining patients."—Abstract from Minutes of the Seventy-Third Annual Session of the A. M. A.

EARLY HOSPITAL HISTORY IN THE UNITED STATES *

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With universal interest rapidly growing in all parts of the United States, in the upbuilding and expansion of the modern hospital, the following contribution of historical data about hospitals seems timely.

It is probable that the first hospital in the United States was the Pennsylvania Hospital. There were earlier institutions in Canada and Mexico, and efforts were set on foot as early as 1709 to establish a hospital in Philadelphia. In 1730-31 the City Almshouse was founded, and did medical work, but it was not until 1750-51 that the Pennsylvania Hospital had its actual birth. A history of this hospital was published by Dr. Thomas G. Morton in 1895.

A number of physicians and leading citizens of Philadelphia presented a petition on January 23, 1751, to the Provincial Assembly, praying for authority and assistance to establish an institution for the care of "the insane and indigent sick." Dr. Thomas Bond and Benjamin Franklin seem to have been most active in working up public sentiment, and pushing the matter before the Assembly. The hospital was finally granted a charter by the Governor May 11, 1751. Joshua Crosby was the first president of the Board of Managers and Benjamin Franklin, the first clerk.

The charter of the Pennsylvania Hospital, after providing minutely for the government and management of the proposed institution, appropriated the sum of two thousand pounds to be paid in two annual installments, conditioned on the raising of a like amount through private contributions. Two thousand seven hundred fifty pounds were subscribed within a short time, and the hospital was organized.

The Board of Managers then petitioned Thomas and Richard Penn, who were then living in England, to donate a site for the hospital. This request after considerable correspondence was finally granted, but with so many restrictions that the board resolved not to accept the gift. As the need of the hospital was pressing, a temporary arrangement was entered into by which a private house was rented, and opened for patients February 6, 1762.

Negotiations were kept up with the Penns, which finally led to the purchase from them of part of the present site in 1754, and the remainder of the land was given to the hospital in 1767.

A suitable site having been obtained, plans were drawn and approved and the building begun. The cornerstone was laid May 28, 1755, and the building was so far completed by December 17, 1756, that patients were moved into it on that date from the temporary quarters.

In the meantime the first president, Joshua Crosby, died in June, 1755, and was succeeded by

* Read before the Santa Cruz County Medical Society, at its meeting held in Santa Cruz March 6, 1922.